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## Efficient urban interchanges: the City-HUB model

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### Abstract

Multimodal trips are increasing in metropolitan areas, making public transport less attractive. There is a need for integration in order to achieve effective seamless mobility. One dimension of integration is to reduce the disruption of transfer among modes and interchanges appear as the best solution when big number of travellers has to transfer.

The City-HUB 7FP project<sup>1</sup> has developed a three years research for deploying new interchanges and improving existing ones. It starts by identifying two groups of dimensions that define Interchange key features. The first dimension is related to Physical&Size, including passenger demand, modes of transport, services and facilities and location in the city. The second dimension is related to Local Impacts such as developing of new activities –housing, offices, nearby shopping-, jobs creation and its connection with the local Development Plan. The combination of the elements of the two dimensions define the following key features: building design, stakeholders' involvement and the type of business model. The findings are based on interviews to practitioners undertaken in 26 selected interchanges in 9 European countries.

According to these key features, the interchange should organize the space among three different zones: access-egress zone; facilities zone; and arrival-departure-transfer zone. The first one is where links to the local area and access to transport modes are focused. The last one caters for intermodal transfers. Travel information and intermodal services are spread across both zones as well as the facilities and retailing.

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<sup>1</sup> This paper is based on the City-HUB project outputs, which has been compiled in the Book City-HUBs: Sustainable and Efficient Urban Transport Interchanges; Editors: Andres Monzon and Florida Di Ciommo (to be published in 2016, CRC Press, Taylor and Francis). Along the paper we will reference it as *City-HUBs Book*.

Users' perceptions should be collected to improve interchange efficiency. To that end a travellers' attitudinal survey has been carried out in interchanges in 5 European cities. From the user point of view the most important factors identified in the surveys are safety and security, transfer conditions, emergency situation, information, design, services&facilities, environmental quality and comfort of waiting time. All these elements define the interchange from two different perspectives: "as a transport node" and "as a place". The first one is related to the functionality as a node of the transport network; the second includes all the features for make the transfer experience more attractive and efficient.

The project has identified a number of recommendations for developing urban transport interchanges. Some of them refers to users, other to operators and the third part deals with local impacts, governance issues and business models. All these findings have served to develop an integrated concept of interchange: City-HUB model.

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**Keywords:** Multimodality; interchanges; seamless urban mobility; urban integration

## 1. Introduction and background

Mobility appears as a fundamental component of the daily lives of people. However, mobility patterns are clearly linked to urban density and the relative location of activities. According to the European Green Paper on Urban Mobility (COM, 2007), just less than 85% of the EU's GDP is created in urban areas which are home to over 60% of the population. It is therefore necessary to ensure a high quality of life in urban areas. Analyses of barriers facing cities in their efforts to achieve a more sustainable development, invariably give a high priority to the problems of mobility and access (Newman and Kenworthy, 1999; UNECE, 2011). One of the main challenges is to achieve accessible urban transport for all, by means of integrating mobility and enhancing collective transport modes. However, public transport accessibility levels are linked to public transport supply, both in terms of number of stops, but also to frequency and quality of services. After more than two decades of a clear trends for urban sprawl, public transport has increasing problems of efficiency to compete with car trips. This tendency could only be counterbalanced through more and better public transport services. Nevertheless, how to dedicate more resources to financing public transport services when they are less and less efficient and competitive due to the negative urban sprawl process. The clear risk is that cities could fall in the so called vicious circle of mobility, where less quality of public transport services would reduce demand producing less income which would have the consequence of reducing more the services and so on.

Although national governments and local authorities make efforts to persuade travellers to switch mode, it seems that public transport still cannot be capable of competing with the private car for many trips (Grotenhuis et al., 2007; Graham-Rowe et al., 2011). From the customers' perspective, the quality of services provided by public transport is not at a satisfactory level that would urge them to replace their car with other modes, i.e. bus, train, tram or combination of them. But, as the world becomes more urbanised, there is a strong need for urban public transport to provide a viable alternative to individual car transport in order to assure more sustainable mobility patterns. However, the availability of opportunities for direct journeys when using public transport is limited, and for this reason the majority of trips require to interchange between services. Hence, there is a need for areas that encompass facilities to interchange and public spaces used for access and/or transfer (Liu et al., 1997).

EU White Papers on Transport Policy pointed out that intermodality is a key factor of daily mobility. The 2001 one (EU, 2001) clearly stated the need for ensuring seamless travel at metropolitan and urban level in Europe. Its mid-term review (EU, 2006) goes one step further assuring that co-modality should be a key element of transport policy. Later, the Action Plan for the Deployment of Intelligent Transport Systems (EU, 2008) and the last White Paper on Transport Policy (EU, 2011) consider that multimodal transport should be based on three pillars: people, integration and technology. More recently, the European Commission (EU, 2013) insisted that the focus should be placed on integrated transportation services, through information provision and intermodal coordination, where different transportation modes are interconnected.

In this context, interchanges interconnecting different transport modes, which complement each other to accommodate a person's journey from its origin to its destination, became key elements of public transport nodes.

When interconnection is properly designed and managed, a lot of benefits arise for users, focusing on time savings, owing to reduced transfer time and efficient travelling. This can be achieved through coordination of public transport services and the provision of integrated information to the users.

Nevertheless, multiple questions arise for providing interchange facilities affecting different planning dimensions. Where to place interchanges within the city fabric? Which factors should be taking into account for designing efficient interchanges? How to organise their space internally? Which functions should be addressed? Which facilities and services are necessary?

The City-HUB project looked for answering those questions in a scientific way, by consulting stakeholders and users in 26 different interchanges located in 9 European countries.

The paper have six more sections. The next one includes a new vision for urban interchanges, which feeds the rest of the paper. Section 3 describes the key elements of an interchange and proposes an interchange typology. Section 4 is about governance and the role of stakeholders while section 5 describes the physical key elements of an interchange. Section 6 provides the users' requirements for adopting intermodal travel patterns and their needs for using the interchange infrastructure. It clearly shows that there are different intermodal strategies related to the type of interchange and the profile of the specific user. Section 7 draws some conclusions.

## 2. City-HUB project vision

Cities require greater effort to improve the understanding of the key factors for increasing public and sustainable transport trips through improving intermodality. The City-HUB project proposes a holistic approach taking into account these different perspectives and including elements affecting the quality of an interchange for the transport services; the different stakeholders; and the city itself (see Figure 1).

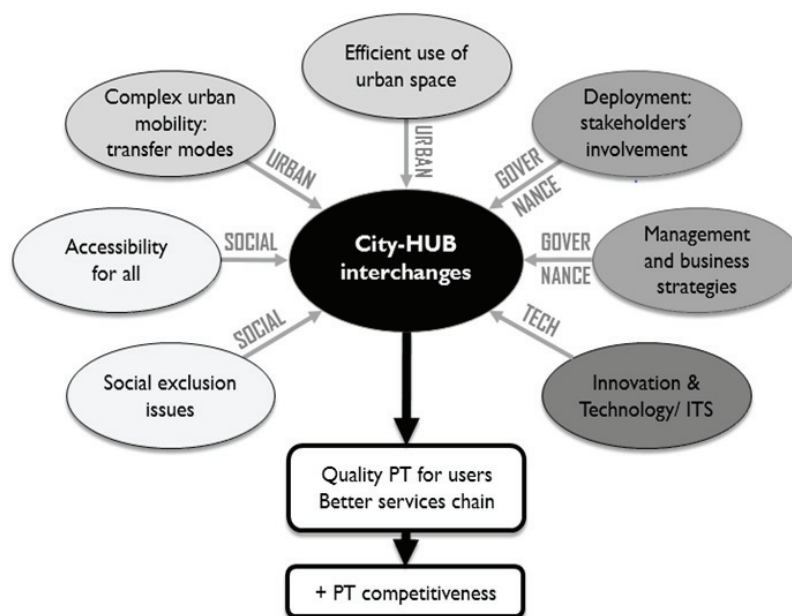


Fig. 1. City-HUB vision of interchanges (Source: City-HUBs Book).

The City-HUB vision of interchanges starts by establishing the needs of urban mobility patterns and how to use scarce space in urban areas for a transport interchange. The function of an interchange station is to reduce distance between transport modes, therefore to facilitate multi-activities patterns. The main added value of the City-HUB vision is that it provides a multidisciplinary approach, which amalgamates relevant scientific and policy aspects. These refer not only to specific mobility issues, but also to technology, economic, land use planning and social

concerns. Figure 1 outlines the main priorities of the City-HUB interchanges. In this context, the quality, accessibility and reliability of transport services have increasing importance, *inter alia* due to the growth of the population, urban sprawl and the need to promote public transport (Ewing et al., 2008; Vuchic, 2005). Comfort, easy access, reliability, attractive frequencies of services and intermodal integration are main characteristics of service quality. The availability of information over travelling time and routing alternatives is equally relevant to ensure seamless door-to-door mobility.

Many metropolitan authorities are implementing policies designed to promote public transportation through increasing the investment in new infrastructure and improving the quality of the public transport services offered. However, in spite of the advantages that promoting public transportation has in terms of the reduction of externalities (pollution, carbon emissions, noise, congestion, and so on), investing in new infrastructure is often very burdensome for municipal and regional governments, who presently are having to face serious budgetary constraints (Di Ciommo et al., 2009). In this context, urban transport interchanges play a key role as components of public transport networks to facilitate the links between different public transportation modes, particularly the connection of bus services to the subway and metropolitan railway system (Vuchic, 2005). Research literature shows that the benefits of urban interchanges mainly relate to time saving, better use of waiting time, urban integration, and improving operational business models (Di Ciommo, 2002).

In summary, the City-HUB project has developed an integrated model which embraces the different aspects of an interchange in order to decrease the barriers to the use of public transport, improve quality, and propose a business model related to the interchange typology. The approach will frame pathways to obtain maximum efficiency by upgrading existing interchanges or by building new ones and make them more efficient and accessible to all users.

### 3. Interchange typologies

Based on the interchange functions and logistics and its spatially location, the empirical work was oriented to define an interchange typology. The exploited data came from a qualitative survey undertaken through interviews with practitioners, transport planners, transport operators or those in charge of the interchange. This information was complemented by the detailed analysis of five pilot case studies, where a quantitative survey was carried out. The analysis of the collected information and opinions identified two “dimensions” or groups of aspects that interact to define the needs of the “interchange place” and consequently the size of the building and its characteristics.

**Dimension A** – Functions and logistics - The first group is related to the functions and logistics aspects, including: demand, modes of transport, and services and facilities. They are not independent and can be defined as follows:

- **Demand** – the number of passengers is the first aspect to define the interchange size; this aspect defines the need for space and access characteristics. Three levels of this aspect are ranged: (1) less than 30,000, (2) between 30,000 and 120,000, and (3) over 120,000 passengers/day.
- **Modes of transport** – the second aspect is related to the modes of transport included in the interchange and their degree of importance. Three different levels resulted from the qualitative analysis: (1) interchanges with buses as the dominant mode of transport; (2) interchanges with rail as the dominant mode of transport; and (3) two or more public transport modes or different lines of the same mode jointly.
- **Services and Facilities** - This group is related to the number and quality of services and facilities located at an interchange. Services and facilities will depend on the volume of passengers transferring in the interchange. It could have three different levels including: (1) a few kiosks or vending machines; (2) a few retail shops, cafes or food facilities for travellers; or (3) the location of a shopping mall integrated with the interchange.

**Dimension B** – Local constraints - This dimension has three interrelated aspects to consider in an aggregated way. The first is related to the relative location of the interchange with respect to the main local demand attractions. But it is also affected by the kind of activities developed around it. If the city considers the transport interchange as part of its urban development plan of the area it is even more important. The description of these aspects is:

- **Location in the city** – the geographical aspect of an interchange is related to its location in the city. The qualitative analysis shows that urban interchanges could be classified as being located in: (1) suburban areas; (2) at the entrance to the city, where major public and private transport modes connect the outside with the inside of the city or a different part of the city; (3) in the city centre.
- **Surrounding area features** – the activities located in the surrounding area could support, or become a limitation to the activities associated with the interchange. Green areas, or heavy industry, could be a limitation, but a large commercial centre or sport fields could foster the use of the interchange.
- **Integrated Development Plan** – the interchange infrastructure could be part of a local development plan to encourage economic and urban development, especially when urban regeneration policies are needed. We can see that commercial development, new housing and offices are more likely to occur when an interchange is an element of the area development plan.

The different aspects included in the two dimensions and their corresponding scores are summarized in Table 1.

Table 1. Interchange Dimensions: Function and Logistics, Local Constraints.

<i>Dimension A</i>		<i>Levels</i>	<i>Need for space</i>	<i>Score</i>
<b>Function and Logistics</b>				
Demand (users/day)	< 30,000		Low	1
	30-120,000		Medium	2
	> 120,000		High	3
Modes of transport	Dominant bus		Low	1
	Dominant rail		Medium	2
	Several modes and lines		High	3
Services and facilities	Kiosks, vending machines		Low	1
	Several shops and basic facilities		Medium	2
	Integrated shopping mall with all facilities		High	3
<i>Dimension B</i>		<i>Levels</i>	<i>Upgrading level</i>	<i>Value</i>
<b>Local constraints</b>				
Location in the city	Suburbs		Less	—
	City access		Neutral	o
	City centre		More	+
Surrounding area features	Non-supporting activities		Less	—
	Supporting activities		Neutral	o
	Strongly supporting activities		More	+
Development plan	None		Less	—
	Existing		Neutral	o
	Existing and including intermodality in the area		More	+

The values given in Dimension A determine the need for space: interchange size. Total score lower than 4 requires an Small interchange. Scores 5-7 indicates the need for a Medium one, while higher than 8 means that the interchange should be rather big, becoming an urban Landmark. Dimension B aspect could be negative, positive or neutral, modifying in this way the previous scores and the type of required interchange. The results allow choosing one of the three basic interchange types showed in Figure 2: cold/hot, partially integrated and fully integrated.

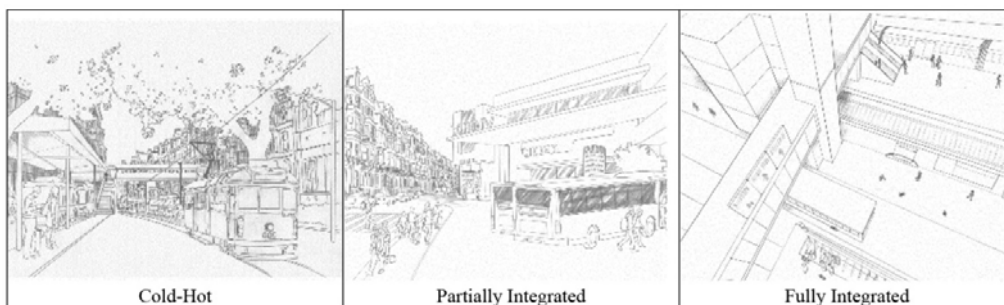


Fig. 2. Types of interchanges according to their functions and local constraints (Source: City-HUBs Book).

#### 4. Stakeholders for deployment and governance of interchanges

Each type of interchange according to the identify functions and local constraints should require the involvement of different stakeholders. Actually, stakeholder engagement reduces conflicts, results in better planning outcomes and most importantly allows communities to have an influence over the future shape of the places where they live. They should be involved along the whole life-cycle of the interchange to assure their successful promotion, deployment, management and monitoring.

A stakeholder is defined as any individual, group or organisation affected by, or able to influence, the proposed project and its implementation. This includes the general public as well as businesses, public authorities, experts and special interest groups. The extent to which stakeholders are affected by a project and able to influence the process to come to a project may differ. Wefering et al. (2013) make a distinction between:

- Primary stakeholders — those who are (positively or negatively) affected.
- Key actors — those who have power or expertise.
- Intermediaries — those who have an influence on the implementation of decisions, or have a stake in the issue (such as transport operators, NGOs, the media etc.).

It is crucial to take account of these differences for selecting the right stakeholders as well as for choosing the best mode for stakeholder engagement and stakeholder management. In addition, the various functional areas should be considered in the selection process. Table 2 shows some typical stakeholder groups that have been identified in the City-HUB project, clustered into five categories.

Table 2. Stakeholder groups for promoting and managing interchanges.

Transport actors	Government/ authorities	Local communities/ neighbourhood actors	Business and commercial	Other
Modal operators (public and private)	Local government	Faith leaders	Local chambers of commerce/ business associations	Universities and educational/ training establishments
Other related transport service operators e.g. taxis	Politicians	Local community organisations/groups (e.g. sports groups, scouting movement etc.)	Retailers or retail/ commercial groups that will use or rent space in the interchange for commercial purposes	Special interest groups (e.g. environmental groups)
Car/bike sharing groups (if their services were planned into the interchange)	Traffic/transport police/ Emergency services	Transport user groups	Local major employers	Experts and consultants
Other mobility providers	Health and Safety executives/ local hospital representatives	Representatives of marginal/ minority or hard to reach groups (by culture/ disability/ age/ gender etc.)		Financial actors
	Neighbouring town council representatives	Local environmental groups		

Source: City-HUBs Book

#### 5. Physical elements of interchanges

Various physical factors are important, including integration with the local area; the different facilities; essential and desirable features; and the different zones of an interchange. Services are a key aspect in determining quality and success. These depend very much on the space available and passenger flows. It is important to consider the most appropriate use of space when deciding which facilities the interchange needs to contain. Figure 3 identifies the three different zones that could be considered within an interchange.

The **Access/Egress Zone** should provide facilities and services for the different types of users arriving at and leaving the interchange: pedestrians, cyclists and motorised transport (such as taxis or kiss and ride). Key facilities that should be provided in this zone are those that assist safe, efficient movement in and out of the interchange such as convenient access; signposting and way-finding; direct routes for pedestrians and cyclists with traffic control measures (such as pedestrian crossings where necessary); and information about the local area, including taxi and



dial a ride information. For those with bicycles or vehicles, secure parking is essential whilst waiting areas with shelters should be provided for those waiting for public transport modes.

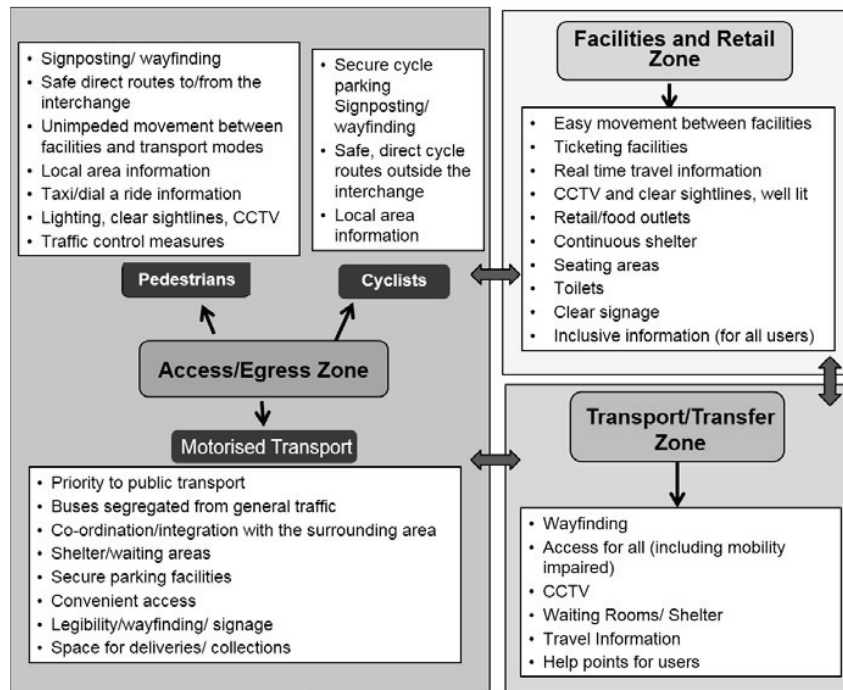


Fig. 3. Interchange zones (Source: City-HUBs Book).

The **Facilities and Retail Zone** is the part of the interchange where users who have more time available to spend at the interchange (such as leisure travellers) can do activities such as shopping or eating while they wait for their transfer. Therefore, shops and food outlets, toilets and seating areas should all be provided. This zone also covers ticketing facilities and should provide real time information to ensure users are kept up to date with any delays or changes to their travel.

The **Transport/Transfer Zone** is where users will be waiting for transport modes within the interchange. Here there should be convenient access for all, which is easy to navigating. Waiting rooms and shelters fitted with CCTV for security should be available to travellers, with up to date travel information and help points if staff are unavailable.

All these three zones are the used by travellers but with different ends and requirements. Different type of users would have different priorities. The users are different according to their personal characteristics (age, professional activity, physical constraints), according to their trip (motives, mode, peak-time or not) and the use of the services and facilities at the interchange. All these should be also analysed and feed the business model of the interchange.

## 6. The users' preferences and requirements

Travellers are particularly sensitive to waiting times, before, after and at interchanges points when using the public transport services (Friman, 2010), and as stated by (Morfoulaki et al., 2010), it is a reason influencing on the perceived quality. In this respect, a transport interchange plays a significant role in the system in terms of its impact on traveller's total travel time (Sun et al., 2012), and its direct influence on the traveller experience and their perception. Therefore, a clear understanding of the users' needs and expectations is crucial to define properly the aspects and elements affecting the transfer experience at an urban transport interchange.

The best way to collect and understand the users' views and needs about their experience is through a satisfaction survey (Hernandez et al., 2015). An ad-hoc questionnaire was therefore designed to capture the views, preferences

and level of satisfaction of travellers. Likewise, since several aspects are relevant in the traveller's decision-making, which are related to their socioeconomic characteristics and their travel habits. The survey was intended to provide a better understanding of the emotional responses to interchanges, such as '*perception of a secure environment*' and '*an agreeable place to spend time when not travelling*'.

A set of 5 urban transport interchanges were selected as pilot case studies in order to capture user's perceptions and assess good and bad practices, obstacles and potential improvements from the daily operations of existing public transport interchanges. They were selected considering a balance in terms of geography and heterogeneity in terms of modes, ownership structure and size (Pitsiava-Latinopoulou and Iordanopoulos, 2012). The case studies selected were:

- Moncloa interchange (Madrid, Spain)
- Kamppi interchange (Helsinki, Finland)
- Ilford Railway Station (London, United Kingdom)
- Köbánya-Kispest interchange (Budapest, Hungary)
- Railway Station of Thessaloniki (Thessaloniki, Greece)

Table 3. Main characteristics of the selected case studies (Source: City-HUBs Book).

Interchange	Year built	Main modes of transport	Pas/day
Moncloa <i>Madrid (Spain)</i>	1995 Refurbish 2008	metropolitan and urban bus metro	287,000
Kamppi <i>Helsinki (Finland)</i>	2005 (operation) 2006 (Shopping)	local and regional bus metro and tram	57,000
Ilford Railway Station <i>London (UK)</i>	1839, rebuilt in 1980 Plans for refurbishment	Rail and buses	21,000
Köbánya-Kispest <i>Budapest (Hungary)</i>	refurbished in 1980 and 2008	Rail, metro Local and regional buses	155,500
Railway Station <i>Thessaloniki (Greece)</i>	1961	Regional rail Urban and regional bus	166,500

Principal Component Analysis (PCA) was applied to the surveys as an analysis methodology to identify the key factors of an urban transport interchange. Through this statistical analysis it is possible to identify latent factors that cannot be directly measured.

The quality perceived by users of a transport interchange, both the infrastructure (building, facilities and so on) and services (information provided, signposting and so on), usually depends on the context of the interchanges (Harmer et al., 2014). However, in the analysis of all cases some key factors and attributes are identified as fundamental in their design, operation and management, despite of the significant differences in the features and context of each interchange. The key identified factors were: *Information, Transfer conditions, Safety & Security, Emergency situations, Design & Image, Environmental quality, Services & Facilities, and Comfort of waiting time.*

These factors define an efficient transport interchange (i.e. an interchange competitive and, at the same time, attractive for users), considering them not only '*as nodes*' within the transport network, but also '*as places*' (see Figure 4). Factors that better define an interchange '*as a transport node*' are aspects related to *information provision* - travel information and signposting - and *transfer conditions* - distances and coordination between operators. In contrast, *design & image, indoor environmental quality, services & facilities* and elements addressed to improve the *comfort of waiting time* are directly linked the quality of the interchange '*as a place*'. Finally, safety & security is of vital importance for users in both approaches. Finally, as concluded by Hernandez and Monzon (2015), improving aspects such as '*Safety and Security*', '*Emergency situations*' and '*Comfort*' would lead to a reduction in the perceived *waiting time*. Moreover, improving aspects such as '*Information provision*' - before trip and at the interchange - and '*transfer conditions*' - particularly, distances and co-ordination between operators - would lead to a reduction in the perceived walking time.



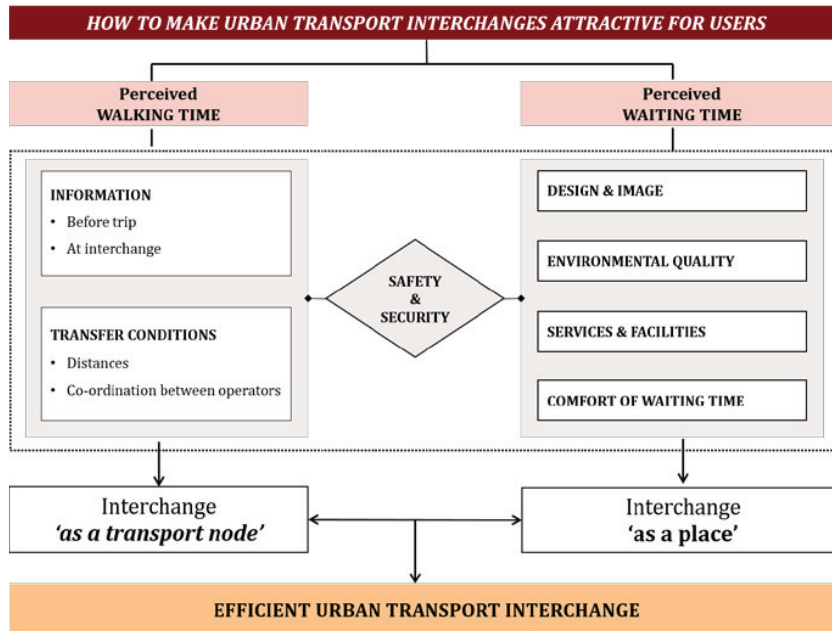


Fig. 4. Key factors identified to make urban transport interchanges attractive for users (Source: Hernandez and Monzon, 2015).

## 7. Conclusions

The French anthropologist Augé (1995) said that multi-modal passenger interchanges are examples of anthropological ‘non-places’ from the social point of view. They are not places where social relations could be developed, and have a lack of sense of history and identity. The City-HUB project clearly stated that interchanges has a transport and a social role for city mobility needs, supporting the goal of transport sustainability. According to Edwards (2011), we have found that a transport interchange is a more complex transport facility than a conventional station that allows travellers to transfer from one mode to another. It said that there are two main definitions of interchange; one related to the infrastructure vision which means that an interchange would be a place where several modes of public transport interconnect. The second vision is based on users: a place where people transfer between two or more public transport modes. The two visions are complementary, but both together do not provide the completed vision of the interchange. It is something more than a building where there several transport modes, and where many people transfer between them. The challenge is to convert a “non-place” into a key element of the transport system which provides clear added value for travellers. If this target is achieved, the weakest point of the system – the need to transfer - could be converted into a strong point to make public transport more attractive and competitive.

The recommendation from the City-HUB Model is to involve all stakeholders in the earliest stage of an interchange building or refurbishment project. Consideration should be given to the needs of different stakeholders, especially interchange users, with potential conflicts discussed and mitigated early in the planning or development process. The functionalities of the interchange should be clearly identified in the light of the different needs and requirements. The result will be the selection of the most appropriate type of interchange and its characteristics. The building design and stakeholders’ involvement represent key features of the interchange. The business model selection depends on the physical aspects of the interchange and its size, and the activities associated with the interchange, both inside and outside. Depending on its intrinsic characteristics and the economic activities generated, each interchange will therefore need a specific business model that could range from less integrated (cold/hot) to a fully integrated interchange. It is necessary a periodical assessment of the interchange to check the achievements of the policy goals in continuous dialogue with stakeholders. The City-HUB outputs propose a methodology to enable this to be undertaken comprehensively and consistently.

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